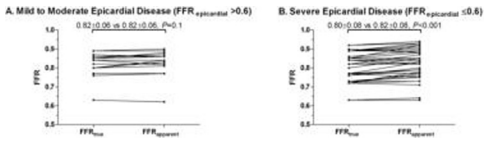
POSTERS

TCT-618

Fractional Flow Reserve Assessment of Left Main Stenosis in the Presence of Downstream Coronary Stenoses: Validation in Humans

Andy S. Yong[1], Gabor Toth[2], Guy Lenders[3], Bernard De Bruyne[2], Catherine Dao[1], David V. Daniels[1], Nico Pijls[3], William F. Fearon[1]
[1]Stanford University Medical Center, Stanford, CA, [2]Cardiovascular Center Aalst, Aalst, Belgium, [3]Catharina Hospital, Eindhoven, The Netherlands

Background: Fractional flow reserve (FFR) measurement can aid in the assessment of left main coronary stenosis. We have previously shown in an animal model that the presence of downstream epicardial stenosis can affect left main FFR measurement. The aim of this study is to explore the effect of stenosis in a downstream epicardial artery on left main FFR assessment in humans.
Methods: After elective coronary intervention of either the left anterior descending (LAD) or left circumflex (LCX) artery, an intermediate left main stenosis was created using an uninflated "winged" balloon. Variable stenoses were then created in the downstream vessel using a balloon inflated within the newly placed stent. A total of 67 pairs of left main FFR assessments in 16 patients were obtained, before and after creation of a stenosis in the downstream vessel, with a pressure wire in the non-stenosed downstream vessel.
Results: The apparent left main FFR in the presence of downstream stenosis (FFRapp) was modestly higher than the true FFR in the absence of downstream stenosis (FFRtrue) (0.82±0.07vs.0.80±0.07, p<0.001). The difference between FFRtrue and FFRapp correlated with composite FFR of the left main plus stenosed artery (FFRepicardial) (r=-0.36, p<0.001), and this difference was only significant when FFRepicardial was severe (figure below). Among the 67 measurements, only 2 (3%) had a difference between FFRtrue and FFRapp of >0.5, and the FFRepicardial was <0.2 in both cases.



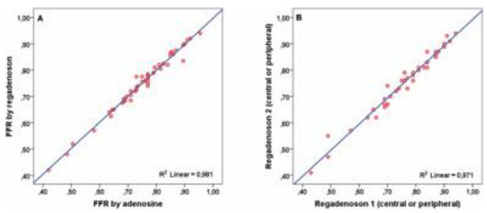
Conclusions: A clinically significant effect on the FFR assessment of left main disease with occurs only when the stenosis in the other vessel is severe.

TCT-619

Single Bolus Regadenoson Injection Versus Central Venous Infusion Of Adenosine To Induce Maximum Coronary Hyperemia For Measurement Of FFR

Lokien X van Nunen[1], Guy Lenders[1], Stéphanie Schampaert[1], Marcel van't Veer[1], Inge Wijnbergen[1], Pim A. Tonino[1], Nico Pijls[1]
[1]Catharina Hospital Eindhoven, Eindhoven, Netherlands

Background: Regadenoson is an A2A-receptor selective hyperemic stimulus known by its rapid onset and simple method of administration. We compared the hyperemic effect of single bolus regadenoson injection to central venous adenosine infusion for measuring Fractional Flow Reserve (FFR). Moreover, time intervals to onset and duration of steady state maximum hyperemia were studied, central venous versus peripheral injections of regadenoson were compared, and safety of repeated injections of regadenoson was investigated.
Methods: Fifty patients with angiographic intermediate CAD scheduled for measurement of FFR were enrolled. FFR was measured twice by central venous adenosine (140 µg/kg/min) and twice by central or peripheral venous regadenoson bolus injection (400 µg) in a randomized sequence.
Results: Patients had a mean age of 65±8 years and 80% was male. The stenosis under investigation was located in the LAD, CX, and RCA in 60%, 28% and 11% respectively. There was no difference in FFR measured by adenosine or by regadenoson (R2 = 0.981, ΔFFR = 0.00±0.02, p<0.001), neither between repeated bolus injections of regadenoson (R2 = 0.971, ΔFFR = 0.00±0.02, p<0.001). The onset of hyperemia was achieved within 29±12s, maximum hyperemia lasted 151s with a wide variation between 15 and >600s. No noticeable side-effects of the drugs were observed.



Conclusions: Regadenoson is an excellent alternative for adenosine to induce maximum hyperemia. Its ease in administration, rapid onset and duration of maximum hyperemia make it an excellent hyperemic stimulus. Repeated injection of regadenoson is safe.

TCT-620

Mean Hyperemic Flow is Not Increased Following Adenosine Administration in Physiologically Significant Lesions

Sukhjinder S. Nijjer[1], Tim P. van de Hoef[2], Ricardo Petraco[3], Sayan Sen[1], M. Meuwissen[4], Rodney A. Foale[5], Martijn A. van Lavieren[2], Christopher Broyd[6], Nicolas Foin[7], Mauro Echavarria-Pinto[8], Ghada Mikhail[9], Iqbal S. Malik[10], Alun D. Hughes[1], Darrel P. Francis[1], Jamil Mayet[1], Javier Escaned[11], Jan Piek[12], Justin E. Davies[1]
[1]Imperial College London, London, United Kingdom, [2]Academic Medical Center - University of Amsterdam, Amsterdam, Noord Holland, [3]Imperial College, London, United Kingdom, [4]Amphia Hospital, Breda, Netherlands, [5]Imperial College Healthcare NHS Trust, London, United Kingdom, [6]Imperial College, London, London, [7]International Centre for Circulatory Health, Imperial College London, London, United Kingdom, [8]Hospital Universitario Clinico San Carlos, Madrid, Spain, [9]Imperial College Healthcare Trust, London, United Kingdom, [10]Imperial College NHS Trust, London, London, [11]Cardiovascular Institute, Hospital Clinico San Carlos, Madrid, Spain, [12]Academic Medical Center, Amsterdam, Netherlands

Background: A central tenant of fractional flow reserve (FFR) is that flow increases following administration of vasodilators. However, animal studies show the increases in flow are limited to mild stenoses and unobstructed vessels, whilst the incremental benefit of vasodilator administration to more significant stenoses may be negligible. In this study, we assess this in humans, using FFR as a physiological measure of stenosis severity over various phases of the cardiac cycle.
Methods: Pressure and flow velocity were simultaneously measured at rest and during adenosine-mediated hyperemia using intra-coronary wires in 146 stenosis in patients undergoing stenosis assessment. Resting and hyperemic whole-cycle flow ($Flow_{Rwc}$ and $Flow_{Hwc}$), resting wave-free flow ($Flow_{wfp}$), and fractional flow reserve were calculated.
Results: In non-significant coronary lesions by FFR, hyperemic whole cycle flow was consistently higher than resting wave-free flow: Δ0.14±0.02m/s in lesions with FFR 0.81-0.90, and Δ0.22±0.04m/s in lesions with FFR 0.91-1.0 (p<0.001 for both). In contrast, in significant lesions by FFR the mean difference in $Flow_{wfp}$ and $Flow_{Hwc}$ was 0.03±0.01m/s when FFR≤0.80 and 0.02±0.01m/s when FFR≤0.75, both significantly less than when FFR>0.80 or >0.75 (p<0.001). Overall in physiologically significant stenoses defined by FFR ≤0.75 or FFR≤0.80, resting $Flow_{wfp}$ represented 100%, and 97% of hyperemic $Flow_{Hwc}$ respectively. In contrast, resting whole cycle flow represented a significantly smaller fraction of $Flow_{Hwc}$ in significant stenoses (76% and 74% respectively, p<0.001 for both) and was significantly lower than $Flow_{wfp}$ for both significant and non-significant stenoses (p<0.001 for all).
Conclusions: Adenosine does not significantly increase flow compared to the wave-free period in stenoses defined as significant by FFR. Adenosine only increases flow compared to resting whole cycle and wave-free period when stenoses are physiologically non-significant. This may have important implications for physiological stenosis assessment.

TCT-621

Advanced Computed Tomographic Modeling of Plaque Geometry for Prediction of Fractional Flow Reserve in Intermediate Coronary Lesions

Maksymilian P. Opolski[1], Cezary Kepka[1], Stephan Achenbach[2], Jerzy Pregowski[1], Mariusz Kruk[1], Adam D. Staruch[3], Adam Witkowski[1]
[1]Institute of Cardiology, Warsaw, Poland, [2]University of Erlangen, Erlangen, Germany, [3]Medical University of Warsaw, Warsaw, Poland

Background: There is still much room for improvement in developing a robust noninvasive model for predicting fractional flow reserve (FFR). We aimed to determine the application of advanced coronary computed tomography angiography (A-CCTA) for predicting invasive FFR in intermediate coronary lesions.
Methods: Sixty-one patients with 71 single intermediate coronary lesions (≥50-80% stenosis) on CCTA prospectively underwent coronary angiography and FFR. Advanced anatomical and morphometric plaque analysis was performed based on CCTA data set to determine optimal criteria for significant flow impairment. A significant stenosis was defined as FFR ≤0.80.
Results: FFR averaged 0.85 ± 0.09, and 19 lesions (27%) were functionally significant. FFR correlated with minimum lumen area (MLA) (r = 0.456, p <0.001), minimum lumen diameter (MLD) (r = 0.326, p = 0.006), reference LD (r = 0.245, p=0.039), plaque burden (r = -0.313, p = 0.008), lumen area stenosis (r = -0.305, p = 0.01), lesion length (r = -0.692, p <0.001), and plaque volume (r = -0.668, p <0.001). There was no relationship between FFR and CCTA morphometric plaque parameters. By multivariate analysis the independent predictors of FFR were lesion length (beta = -0.581, p <0.001), MLA (beta = 0.360, p = 0.041), and reference LD (beta = -0.255, p = 0.036). The optimal cutoffs for lesion length, MLA, MLD, reference LD, and lumen area stenosis were >18.5mm,

≤3.0mm2, ≤2.1mm, ≤3.2mm, and >69%, respectively (max. sensitivity: 100%, max. specificity: 79%).

CCTA predictors for invasive FFR as a continous variable

	Beta coefficient	95% CI	P-value
Lesion location in LAD	−0.157	−0.062 to 0.003	0.071
Mean reference LD	−0.255	-0.094 to -0.003	0.036
MLA	0.360	0.001 to 0.069	0.041
MLD	−0.042	-0.089 to 0.067	0.780
Lesion length	−0.581	−0.007 to −0.003	<0.001
Plaque burden	−0.131	-0.005 to 0.001	0.152

Conclusions: The CCTA-derived anatomical triad of lesion length, MLA, and reference segment LD independently predicts invasively determined FFR. CCTA might be used as a gatekeeper to exclude significant ischemia in the subset of lesions with ≥50% luminal narrowing.

TCT-622

Assessment of Noninvasive Coronary Flow Velocity Reserve Before and After Recanalization of Chronic Total Occlusion

Oytun A. Baykan[1], Gulhan Y. Kalkan[1], Durmus Y. Sahin[1], Zafer Elbasan[1], Mustafa Gur[1], Taner Seker[1], Caner Turkoglu[1], Murat Cayli[1]
[1]Adana Numune Training and Research Hospital, Adana, Turkey

Background: Coronary flow velocity reserve (CFVR) has been considered an important diagnostic index of the functional capacity of coronary arteries. A donor artery providing collateral distal to a chronic total occlusion (CTO) may have diminished blood flow. The aim of this study was to evaluate, by noninvasive CFVR, whether the blood flow of donor artery reverts to normal after successful percutaneous coronary intervention (PCI) of CTO.
Methods: We evaluated 25 patients (20 men, 5 women; mean age 57.5±14.1 years) who underwent successful PCI of right coronary artery (RCA) CTO, whose collateral provided by left anterior descending artery (LAD). The coronary flow velocities in the distal LAD were measured using transthoracic Doppler echocardiography at rest and during hyperemia induced by intravenous infusion of adenosine at 3 time periods; before (basal), 24 hours after (early) and within 3 months (late) of successful PCI. CFVR was calculated as the hyperemic to resting coronary diastolic peak velocities ratio.
Results: There was no difference between basal, early and late left ventricular ejection fraction values (53.5±10.2, 53.3±9.5, 53.3±11.2, respectively). The CFVR at third month was significantly increased compared to the basal and early CFVR (1.8±0.3 vs. 2.3±0.3; p <0.001 and 1.8±0.2 vs. 2.3±0.3; p<0.001, respectively). On the other hand, there was no significant difference between basal and early CFVR (1.8±0.3 vs. 1.8±0.2; p=0.89, respectively).

Table 1. LAD CFVR values before and after recanalization of RCA CTO

	Basal	Early	Late	P1	P2	P3
CFVR	1.8±0.3	1.8±0.2	2.3±0.3	0.89	<0.001	<0.001

P1: basal vs. early CFVR, P2: basal vs. late CFVR, P3: early vs. late CFVR, values are mean±std. deviation

Conclusions: In this study, we have shown that successful recanalization of CTO results in increased CFVR-indicated blood flow in the donor artery within 3 months.

TCT-623

Area Of Myocardium At Risk And Lesion Length Are Predictors Of Functionally Significant Coronary Artery Stenoses Assessed By Fractional Flow Reserve

Dennis Wong[1], Om Narayan[2], Brian S. Ko[2], James Cameron[1], Darryl Leong[3], Sujith Seneviratne[1], Ian T. Meredith[4], Yuvaraj Malaiapan[5]
[1]MonashHeart, Clayton, VIC, [2]MonashHeart, Monash Cardiovascular Research Centre, Clayton, Victoria, [3]Leiden University Medical Centre, Wassenaar, Leiden, [4]Monash University, Melbourne, Australia, [5]Monash Medical Centre, Clayton, Victoria

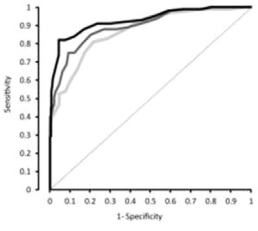
Background: Angiographic evaluation of diameter stenosis has only modest predictive value for functionally significant coronary-artery-stenoses as assessed by fractional-flow-reserve (FFR). Lesion length and assessment of area of myocardium at risk (BARI-myocardial-jeopardy-index) subtended by the stenotic coronary arteries are also predictors of functionally significant coronary-artery-stenoses. We compared the diagnostic accuracy of minimal-lumen-diameter (MLD), lesion length and BARI-myocardial-jeopardy-index (MJI) in prediction of significantly reduced FFR (≤0.8).
Methods: We assessed consecutive patients who underwent coronary angiography and FFR. Lesion length and MLD were assessed by QCA. Estimation of area-of-myocardium at risk subtended by coronary stenoses was performed using the BARI-MJI. Coronary stenoses were classified as functionally significant when FFR was ≤ 0.8.
Results: 196 consecutive patients (age 65.6 ± 10.9; 69% male, 306 vessels) were included. 117 vessels (51%) had FFR ≤ 0.8. The BARI MJI was 34.2 ± 13.8 in vessels with FFR ≤0.8 compared to 21.8 ± 11.0 in vessels with FFR >0.8 (p<0.001). The mean lesion length in vessels with FFR ≤0.8 was 18.7 vs 9.37 mm in vessels with FFR >0.8 (P <0.001). The MLD in vessels with FFR ≤0.8 was 1.16 ± 0.458 mm compared to 1.51 ± 0.470 mm in vessels with FFR > 0.8 (P <0.001). The bootstrapped Harrell's c-statistic of BARI MJI, lesion length and MLD in predicting significant FFR were 0.76 (0.71-0.82), 0.75 (0.70-0.80) and 70 (0.65-0.75) respectively.
Conclusions: Diameter stenosis alone has modest predictive value of significant FFR. Area of myocardium at risk and lesion length are also predictors of functionally significant coronary artery stenoses.

TCT-624

Real-time utilisation of instant wave-free ratio (iFR) is feasible when performed by clinicians: results of the ADVISE in-practice, an international, multi-centre evaluation of iFR in clinical practice

Ricardo Petraco[1], Luc Janssens[2], Eric van Belle[3], Farrel Hellig[4], Martin Mates[5], Steven Haine[6], Kunihiro Sakoda[7], Ciro Indolfi[8], Andrew Sharp[9], Rasha Al-Lamee[10], Nobuhiro Tanaka[11], Waldemar Bojara[12], Flavio L. Ribichini[13], Christian Vrints[14], Tim P. van de Hoef[15], Carlo Di Mario[16], Javier Escaned[17], Matthias Gotberg[18], Mauro Echavarria-Pinto[19], Hitoshi Matsuo[20], M. Meuwissen[21], Jan Piek[22], Hiroyoshi Yokoi[23], Justin E. Davies[16]
[1]Imperial College, London, United Kingdom, [2]Imelda Hospital Bonheiden, Bonheiden, Antwerp, [3]Hôpital cardiologique CHRU Lille, Lille, France, [4]Sunninghill & Sunward Park Hospitals, Johannesburg, South Africa, [5]Na Homolce Hospital, Prague, Czech Republic, [6]Antwerp University Hospital, Antwerp, Belgium, [7]St.Luke's International Hospital, Tokyo, Japan, [8]University Magna Graecia, Catanzaro, Italy, [9]San Raffaele Scientific Institute, Milan, Italy, [10]Imperial College NHS Trust, London, London, [11]Tokyo University Hospital, Tokyo, Japan, [12]Koblenz-Mayen Hospital, Koblenz, Germany, [13]Università di Verona, Verona, Italy, [14]University of Antwerpen, Antwerpen, Belgium, [15]Academic Medical Center - University of Amsterdam, Amsterdam, Noord Holland, [16]Imperial College London, London, United Kingdom, [17]Cardiovascular Institute, Hospital Clinico San Carlos, Madrid, Spain, [18]Lund University, Lund, WI, [19]Hospital Universitario Clinico San Carlos, Madrid, Spain, [20]Gifu Heart Center, Gifu, Japan, [21]Amphia Hospital, Breda, Netherlands, [22]Academic Medical Center, Amsterdam, Netherlands, [23]Kokura Memorial Hospital, Kitakyushu, Japan

Background: Instant wave-free ratio (iFR) is a new index of coronary stenosis severity calculated without the need for vasodilators. iFR uses automated algorithms over baseline pressure traces to detect a phase in the cardiac cycle when resistance is lowest and most stable. Previous studies have calculated iFR offline, and the feasibility of real-time iFR measurement has never been assessed. In this study we explore the real-time iFR measurement in humans undergoing invasive functional assessment of intermediate coronary stenoses.
Methods: 392 angiographically intermediate stenoses from 16 centers in Europe, Asia and Africa were included. iFR and FFR were measured in real-time, by clinicians, on clinically available consoles. The agreement between iFR and FFR was calculated for both clinical (0.80) and ischaemic (0.75) FFR cut-offs.
Results: iFR and FFR maintain a close level of agreement when both are measured by clinicians in real-time (for a ischaemic 0.75 FFR cut-off: ROCAUC 0.90, classification match 88%; for a clinical 0.80 FFR cut-off: ROCAUC 0.87, classification match 80%; if the FFR 0.75-0.80 gray zone is accounted for: ROCAUC 0.93, classification match 92%). The diagnostic performance of iFR is summarized in Figure 1.



Classification agreement between iFR and FFR

	FFR 0.8	FFR 0.75	FFR gray zone*
iFR cut-off	0.9	0.85	0.85
ROC AUC	0.87	0.90	0.93
Classification match	80%	88%	92%
Sensitivity	81%	75%	82%
Specificity	79%	91%	96%
PPV	71%	70%	86%
NPV	87%	93%	95%

* Accounting for the 0.75 - 0.8 FFR gray zone

Conclusions: iFR measurement is feasible and practical for clinicians in a real world setting. By simplifying stenosis evaluation, iFR may expand adoption of physiology-guided revascularization.

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